DESIGN AND DEVELOPEMENT OF HYDROXYAPATITE/ZIRCONIA (HA/ZrO_2) SCAFFOLD FOR GUIDED BONE REGENERATION

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For the love one and his prophet.

Specially dedicated to my father, Mamat bin Muda, and my mother,

Laili binti Mukhtar and to all my friends.

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ABSTRACT

Highly porous scaffold made of bioceramics such as hydroxyapatite (HA) have been widely investigated for guided bone regeneration, however their inferior mechanical strength limits their clinical use to non load bearing applications. In this study we have synthesised HA/ zirconia (ZrO_2) mixtures (5, 10, and 20 wt%) using microwave assisted wet precipitation method. Phase composition and particle morphology of the mixture was studied using X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) respectively. Presence of ZrO_2 in mixtures was confirmed by the presence of peak at 30.22° in XRD, which increased in intensity as concentration of ZrO_2 increased in the mixture. Porous structures were generated by using polymeric sponge burn off method. Solid loading of sponge was optimised to achieve good degree of porosity, pore size and pore interconnectivity. SEM analysis of scaffolds revealed good pore interconnectivity and pore size greater than 200 microns. Scaffolds were dipped in solution of poly-L-lactic acid and HA/ZrO_2 prior to the compressive strength measurements. The compressive strength of scaffold increased from 1.73 to 2.47 MPa when ZrO_2 content increased from 5% to 20% for 20 wt% solid loading. For 30 wt% solid loading, compressive strength increased from 1.83 to 2.63 MPa as concentration of ZrO_2 increased.

ABSTRAK

Bahan perancah yang mempunyai keporosan yang tinggi yang diperbuat daripada bioseramik seperti hidroksiapatit (HA) telah banyak dikaji untuk memandu pertumbuhan semula tulang, namun kekuatan mekanikalnya lebih rendah mengehadkan penggunaan klinikalnya untuk aplikasi bukan galas beban. Dalam kajian ini, kami telah sintesis mencampurkan HA/zirconia (ZrO_2) dengan nisbah (5, 10 dan 20 wt%) dan menggunakan kaedah pemendakan basah dengan bantuan gelombang mikro. Komposisi fasa dan morfologi zarah sebatian telah dikaji masing-masing dengan menggunakan pembelauan X-Ray (XRD) dan pengimbas mikroskopi electron (SEM). Kehadiran ZrO_2 di dalam sebatian ditentukan oleh kehadiran puncak pada 30.22˚ didalam XRD, dimana keamatan meningkat dengan penambahan kepekatan ZrO_2 didalam sebatian. Struktur berliang telah dihasilkan dengan menggunakan kaedah membakar span polimer. Memuatkan pepejal dalam span dioptimumkan untuk mencapai darjah keporosan yang bagus, saiz liang dan liang yang saling bersambung. Analisis SEM bahan perancah menunjukkan rongga yang saling bersambung dan saiz rongga yang lebih besar daripada 200 mikro. Bahan perancah direndam kedalam asid larutan poli-L-laktik dan HA/ZrO_2 untuk meningkatakan ukuran kekuatan kemampatan. Kekuatan mampatan bahan perancah meningkat daripada 1.73 hingga 2.47 MPa apabila kandungan ZrO_2 meningkat daripada 5% kepada 20% bagi 20 wt% kemasukan pepejal. Bagi 30 wt% kemasukan pepejal, kekuatan mampatan meningkat daripada 1.83 hingga 2.63 MPa dengan peningkatan kepekatan ZrO_2.